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THE DETERMINATION OF NUTRITIONAL REQUIREMENTS
FOR SAFE HAVEN FOOD SUPPLY SYSTEM
(EMERGENCY/SURVIVAL FOODS)

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Final Report

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ABSTRACT

The Space Station Safe Haven Food System must sustain eight crew members under emergency conditions for 45 days. Sustaining the crew members in an emergency situation following the requirements for minimal volume and maximum shelf life is a challenging part of the Space Station planning. Determination of the nutritional requirements for an emergency/survival ration for Space Station Safe Haven is one of the current research objectives at JSC.

Emergency/Survival Foods are defined as a nutritionally balanced collection of high density foods and beverages selected to provide for the survival of Space Station flight crews in contingency situations.

Safe Haven Foods will be used only in emergency situations. Since storage volume is limited, the foods should be highly concentrated. They will be designed to fulfill one purpose: sustaining the life of the crew during a period of emergency. Advances in food science and technology continue to increase the capability to respond to this challenge.

Recommended dietary composition and special considerations during Safe Haven: A careful study of different research findings regarding starvation and calorie restricted diets indicates that a minimum nutritional need close to RDA is an important factor for sustaining an individual's life in a stressful environment. Fat, protein, and carbohydrates are three energy producing nutrients which play a vital role in the growth and maintenance process of human life. A lower intake of protein can minimize the water intake, but it causes a negative nitrogen balance and a lower performance level. Other macro and micro nutrients are also required for nutritional

interrelationship to metabolize the other three nutrients to their optimum level. Therefore, 2000kcal of Space Station Safe Haven Emergency/Survival Food is recommended on the basis of 10% kcal should come from protein; 60% from CHO; 30% from fat, for 45 days. The various options for longer durations (e.g., 180 to 235 days) are also under investigation. There are some foods also taken under consideration as possible candidates for Space Station Safe Haven Foods.

INTRODUCTION

The Space Station Safe Haven Food System must sustain eight crew members under emergency conditions for 45 days. Sustaining the crew members in an emergency situation following the requirements for minimal volume and maximum shelf life is a challenging part of the Space Station planning. Determination of the nutritional requirements for an emergency/survival ration for Space Station Safe Haven is one of the current objectives at JSC.

Emergency/Survival Foods are defined as a nutritionally balanced collection of high density foods and beverages selected to provide for the survival of Space Station flight crews in contingency situations.

Safe Haven Foods will be used only in emergency situations. Since storage volume is limited, the foods should be highly concentrated. They will be designed to fulfill one purpose: sustaining the life of the crew during a period of emergency. Advances in food science and technology continue to increase the capability to respond to this challenge.

The nutritional criteria will be based on the activity level necessary for routine station operations during both Intravehicular Activities (IVA) and Extravehicular Activities (EVA). Following are the assumptions used in determining the Safe Haven Food System for the Space Station:

- A. Two module station with resource nodes
- B. An 8-member crew with a planned 90-day resupply cycle
- C. A modified food system reduced from a proposed 0.66 cu. ft./man/day to 0.20 cu.ft./man/day
- D. The weight (packing density) of all equipment and supplies is calculated to be 22 lbs./cu.ft. The logistics module provides 213 cu.ft. of food stowage volume and the galley provides 165 cu.ft. of food stowage volume for routine station operations
- E. The amount of crew time required to maintain the system will not exceed 1 hour/45 days
- F. The availability of power in a Safe Haven node shall be provided by other systems

The assumptions made are based on previous space flight experience. The numbers provided in the assumptions may change as new information becomes available. The focus of this paper is on the nutritional criteria. (15)

In the selection of foods for the Safe Haven System, consideration needs to be given to their:

- A. Functions in the body
- B. Nutritional contribution
- C. Relationship with the normal daily menus of the Food Supply and Service System (FSSS)

PURPOSE OF THE STUDY

The purpose of the study was to evaluate potential food types and recommend candidate methods for meeting the nutritional requirements for the Space Station Safe Haven Food System.

OBJECTIVES

1. To determine the overall nutritional requirements for Safe Haven food supply systems
2. To recommend an emergency ration providing the minimum number of calories/man/day required to prevent weight loss
3. To establish a knowledge base of the specific nutrients required and their metabolic effect on the health of Space Station crew members in terms of stress and performance.
4. To determine the minimum water requirements for Safe Haven
5. To determine the minimum Safe Haven Food shelf life requirements
6. To recommend potential Safe Haven foods

REVIEW OF THE LITERATURE

C. F. Consolazio and his associates (1971) conducted research in Metabolic Imbalances and Body Hypohydration During Food Deprivation (10 days). In the initial study of 6 men who fasted completely for 10 days, significant metabolic stresses developed which could have eventually led to serious abnormalities. These observations included a great amount of body dehydration which resulted in substantial body weight loss in the test subjects, coupled with large nitrogen and mineral losses, and a marked ketosis. (10)

Three studies on complete starvation and restriction of caloric intake, each lasting 10 days, will be discussed. In the first study, 6 healthy adult males between the ages of 21 and 52 years were placed on a starvation diet for 10 days. Water was available ad libitum. (13)

The major problems encountered during 10 days of complete starvation were:

- A. Large body weight losses - averaged 7.27 kg or 9.5% of the total body weight
- B. Highly negative water balances resulting in great body dehydration
- C. Negative nitrogen balances indicating that excessive body protein was being catabolized
- D. A marked ketosis
- E. Large mineral losses
- F. Abnormal EKG's in all subjects during the experimental phase

In the second study, the subjects were 8 young male volunteers who engaged in an intensive physical training program prior to the onset of the study. The study consisted of 3 phases: a control period of 8 days, followed by a 10-day period of caloric restriction, and then an 8-day rehabilitation

phase. Group I received no mineral supplementation, while Group II was given mineral supplements. No vitamin supplements were given to any of the subjects during the caloric restriction period. The diet used during the restriction period contained 420 cal/day of carbohydrate. Energy expenditure was maintained at the 3200 cal/day level. The second study was designed to minimize protein catabolism, decrease electrolyte excretion, eliminate ketosis, maintain the water balance by feeding a small quantity of carbohydrates (100 gm), and to observe the effect of mineral supplements on these metabolic factors. The study showed that mineral supplementation under the experimental conditions did not affect the nitrogen balance.

The third study, a 500 cal/day diet, showed that 500 calories/day are inadequate for short term performance. Although they spared water, the protein catabolism was still a major problem. (13)

According to H. J. Krzywicki, et.al. (1972) in their 420 Kcal study, weight loss was 15 percent greater when minerals were totally excluded. The losses were less severe than the 9.5 percent loss observed during the starvation study conducted by Krzywicki in 1968. The addition of 40 gm of protein to the diet resulted in losses of 7.6 percent in Group I and 6.5 percent in Group II, which were not dissimilar from the 8.1 and 5.9 percent losses observed during the 420 Kcal study. (19, 20)

The weight losses in Group I closely approximated values reported in the Brozek study (7.7 percent loss after 12 days on a 500 Kcal carbohydrate intake). Observations made by Grande, et.al., show 4.5 percent losses in body weight when male test subjects were fed a 1000 Kcal/day carbohydrate diet for 16 days. They also had negative water balances in spite of a 4.5 gm/day NaCl intake. Therefore, neither the 1000 Kcal, 40 gm of protein, nor mineral supplements prevented water loss. (6, 16)

The weight loss was calculated to be 65 percent fat in Group I and 59 percent fat in Group II in the study conducted by Krzywicki (1979). This was markedly different from the 22-24 percent loss attributable to fat when a diet of 420 Kcal of carbohydrates was used. Brozek reported that fat loss constituted 40 percent (190 gm/day) of the total body weight lost. Group I lost 360 gm/day, while Group II lost 276 gm/day of fat. This suggests that fat stores were mobilized and utilized to a greater extent when protein was added to the diet.

In the study by Krzywicki, protein values are in agreement with the findings of Brozek who reported that 9 percent of the body weight loss was protein. In the Krzywicki study, 390 gm of dry protein constituted 7 percent of the body weight lost in Group I and 8.4 percent in Group II, in view of the fact that the protein estimate was calculated as only 20.2 percent of the fat free mass. Water losses were reduced, but some dehydration occurs with caloric restriction. In conclusion, during the 500 Kcal/day diet comprised of 85 gm of carbohydrates and 40 gm of protein, the weight loss was comprised of 59 to 65 percent fat, 8.4 percent of dry protein, and 25 to 28 percent water. (6, 21) Johnson, et.al. (1971), in his Metabolic Aspects of Calorie Restriction Study, showed that negative nitrogen balances averaged 7.1 and 6.5 gm/man/day, and no improvement in nitrogen balances was observed. The protein loss accounted for approximately one-fourth of the weight loss in the experimental group. (17)

The U.S. Army Research Institute of Environmental Medicine, located in Natick, MA, conducted a study relating nutritional status with the physical

and mental performance of special operations troops consuming the Ration, Light-Weight (RLW), or the Meal, Ready-to-Eat (MRE), military field ration. The study was conducted during a 30-day field training exercise. The MRE is designed to provide adequate nutrition under operational conditions and provides 3900 Kcal/day (3 packages, 1300 Kcal/package). The RLW-30 was designed for special operations that do not permit resupply over an extended period of time (30 days). A 30-day field test of the RLW-30 ration showed that the troops were adequately sustained with a minimal weight loss. All participants stayed within the acceptable weight loss of 6.3% of their original body weight. The MRE was tested at the same time as a control group and was found to have sustained the group to within 2.2% of their original body weight. The significant difference between the weight losses in the study was that the MRE group lost only body fat, whereas the RLW-30 group lost both lean body mass as well as body fat. (1)

It has been shown that many abnormalities are associated with long term starvation. Canadian prisoners of war (POWs), who had been on restricted diet in camps in Singapore and Hong Kong during World War II, were subjects of a study conducted more than 10 years after they were released. Some of the most frequent symptoms observed in the study group included: fatigue with low levels of effort, profuse sweating for no apparent reason, numbness and cramps in the calf muscles, loss of ambition, poor vision, edema, dyspnea with even the slightest exertion, depression, anorexia, nausea, restlessness, irritability, and insomnia. (7)

DISCUSSION

The intended purpose of the Safe Haven Food System is to allow flight crew members to continue to live and function in space in an emergency situation. During an emergency, the regular food supply may be inaccessible by loss of a node or module or rendered unusable by accident, lack of power, etc., necessitating the use of a contingency food system. The current provisions for Space Station emergency management are Safe Haven and the Health Maintenance Facility (HMF), which together include: (15)

- Water
- Food
- Food Preparation Equipment
- Utensils
- Wipes
- Waste Management Provisions
- Trash Management Provisions
- Personal Hygiene Provisions
- Towels
- Clothing
- Sleep Restraints
- Health Maintenance Provisions
- Lighting
- Exercise Equipment
- Communication Equipment
- Tools

First Aid Kit

Possible Space Station emergencies may be caused by:

- Fire
- Collision with Orbital Debris
- Loss of Temperature Control
- Loss of Pressurization
- Contamination
- Loss of Attitude Control
- Explosion
- Meteoroid Penetration
- Grazing Collision
- Illness/Injury
- Depletion of Consumables
- Inadvertent Operation

Should such an emergency occur, a decision would have to be made either to allow the crew to continue to live on the Station for up to 45 days to wait for the next launch of the Shuttle, or to return the crew to Earth in a Crew Emergency Return Vehicle (CERV). The first option would require the crew to maintain, or regain and maintain control of the Station. If all systems fail, the decision would be to bring the crew members home safely. Either decision will require a special food system to maintain the health of the crew members until a rescue can be completed or the emergency situation is corrected.

The CERV will be a dedicated rescue vehicle which will be attached to a node. During a rescue using the CERV, the maximum stay in the vehicle will be one day in orbit and one day on the ground. The CERV will have sufficient food and water stowage for a crew of 8 for the two-day period. A menu needing a minimum of preparation and no preparation equipment will be required in the small quarters of the CERV. During a rescue mission, use of survival type food would be a more logical approach than use of a nutritionally balanced diet. The crew will have no special physical activities which would require the normal daily food supply of 3000 Kcal. A high density food bar containing 500 to 900 Kcal should be sufficient to meet the temporary needs.

The rationale of this recommendation is based on:

- A. Weight and volume limitations
- B. Lack of sufficient power
- C. Space available for food preparation
- D. Quality and quantity of food required

The research findings from the various sources indicate that, during complete starvation, body dehydration results in conjunction with substantial body weight losses, large nitrogen and mineral losses and marked ketosis. These findings are not unusual since both the body fat and protein stores must be utilized as energy sources. The maintenance of normal blood carbohydrate levels requires a known quantity of protein breakdown. A low anti-ketogenic diet and adequate mineral supplements could prevent the marked ketosis, minimize protein catabolism, maintain fluid balance, and decrease

the electrolyte excretion. The large losses of total nitrogen in urine during caloric restriction are still indicative of catabolism of body protein for gluconeogenesis and energy. Studies have indicated that the body has labile stores of protein reserves which are readily lost during adaptation to low protein or low caloric diets. (8, 9, 11, 18)

The recommended Space Station menu developed by the Food Supply and Service System study team conforms to the current Government nutritional guidelines, and contains as a minimum:

- A. Four servings of fruits and vegetables
- B. Two servings of meat, poultry, fish, or vegetable protein equivalent
- C. Four servings of grain based (cereal) foods, with an emphasis on whole grain foods where possible
- D. Two servings of milk or its calcium equivalent

(see TABLE I - RECOMMENDED DAILY DIETARY ALLOWANCES OF NUTRIENTS)

TABLE I - RECOMMENDED DAILY DIETARY ALLOWANCES OF NUTRIENTS

NUTRIENT	DAILY ALLOWANCE (1)	
	MALES	FEMALES
Kilocalories, kcal	2300-3100 (2)	1600-2400 (2)
Protein (3), g/kg	0.8	0.8
Vitamins		
Thiamin, mg	1.4	1.0
Riboflavin, mg	1.6	1.6
B6, mg	2.2	2.0
B12, μ g	3.0	3.0
Folacin, μ g	400	400
Niacin, mg	18	13
C, mg	60	60
A, μ g, (as retinal equivalents)	1000	800
D, μ g (as cholecalciferol)	5	5
E, mg (as tocopherol equivalents)	10	8
Minerals		
Iron, mg	10	18
Calcium, mg	800	800
Phosphorus, mg	800	800
Magnesium, mg	350	300
Zinc, mg	15	15
Iodine, μ g	150	150
ESTIMATED SAFE AND ADEQUATE INTAKES FOR ADULTS		
Vitamins		
Pantothenic acid, mg	4-7	
Biotin, μ g	100-200	
K, μ g	70-140	
Electrolytes		
Sodium, mg	1100-3300	
Potassium, mg	1875-5625	
Chloride, mg	1700-5100	
Minerals		
Manganese, mg	2.5-5.0	
Selenium, μ g	50-200	
Molybdenum, μ g	150-500	
Copper, mg	2.0-3.0	
Chromium, μ g	50-200	
Fluoride, mg	1.5-4.0	
Levels of nutrients are based on the NAS, NRC, and the Committee on Dietary Allowances.		
(1) Allowances are for adults, age 23-50		
(2) Kilocalorie allowance may vary depending on body size, weight, and work load.		
(3) Includes a balanced (nonlimiting) level of the nine essential amino acids, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine.		

Current research findings of the nutritional requirements of man in space, and ground based studies on the impact of restricted diets on the survival of human life indicate that there is a crucial need to recommend a nutritional guideline for Safe Haven foods for longer duration use. The Safe Haven menu should follow as closely as possible the recommended daily allowances (RDA). (15,22)

NUTRITIONAL REQUIREMENTS

Recommended dietary composition and special considerations during Safe Haven:

1. The large losses of total nitrogen in urine during caloric restriction are still indicative of catabolism of body protein for gluconeogenesis and energy. Therefore, a minimum of 10 percent protein (40 gm) should be included in the Safe Haven Food System. A limit of up to 10 percent protein can minimize the water intake required.
2. During complete starvation, significant metabolic stress can develop which eventually may lead to serious abnormalities such as: body dehydration, nitrogen loss, mineral loss or a marked ketosis. Hence, the Safe Haven Food System should be comprised of at least 60 percent (300 gm) carbohydrates which may prevent ketosis and other abnormalities. The addition of 40 gm of protein to the calorie restricted diet may also increase the utilization of fat.
3. A body weight loss is normally attributed to a calorie restricted diet. Brozek reported loss of fat contributed 40% of the total body weight loss in his low calorie carbohydrate diet. Therefore, at least 30 percent (66 gm) fat should be included in the Safe Haven Food System. (6)
4. The moisture content of each food item deserves consideration as a natural source of water to maintain body fluid levels.
5. Preparation time is an important criteria in the selection of food items for Safe Haven.

TABLE II - PROPOSED FOOD MIX & FOOD TYPES

FOOD MIX	FOOD TYPE	PERCENT OF FOOD ITEMS	PERCENT OF BEVERAGE ITEMS
50% MRE	THERMOSTABILIZED	50-60	---
50% WITH MINIMUM PREPARATION	INTERMEDIATE MOISTURE/NATURAL FORM	20-30	---
	REHYDRATABLE	15-20	100

The appearance, odor, flavor, and familiarity of Safe Haven Food for Space Station should be comprised of typical Earth-like characteristics, but not limited to it under the special circumstances. It must be of optimum utility and also have choice in menu selection on board the Space Station. A minimum of 7 and possibly of a 12-day menu cycle is also suggested criteria for Safe Haven.

According to the Manned Module Configuration, there will be Hab and Lab in Space Station. In the Lab section of Space Station, a possible suggestion is to keep a food warmer like Shuttle's to provide a facility for minimum food preparation. Therefore, determination of percentage of power utilization during food preparation at minimum rate needs to be studied. An easy access to food, water, and accessory hardware items should be facilitated by the system. A specific routine inventory should be required for leakage, bulges, tears, and other anomalies in sufficient time for each resupply mission. (15)

The characteristics and discussions about possible Space Station Safe Haven Foods (Emergency/Survival) are as follows:

TABLE III - MAJOR CHARACTERISTICS OF CANDIDATES

RATION	PROPERTY OF FOOD CONTENTS
Meal ready to eat (MRE)	<ul style="list-style-type: none"> • Thermostabilized • Contains Water • Palatable • Ready to eat • 84-month maximum storage at 70 degrees F
Ration lightweight 30 days (RLW-30)	<ul style="list-style-type: none"> • Dehydrated • Low volume • No water - needs water source • 36-month storage at 100 degrees F
Nutritional sustainment module (NSM)	<ul style="list-style-type: none"> • Dehydrated • Low volume • No water • High calorie value
Shuttle foods (emergency survival ration)	<ul style="list-style-type: none"> • Thermostabilized • Dehydrated

MRE (Meal Ready-To-Eat)

The Meal Ready-To-Eat provides individual meals containing food components that are ready to eat under conditions precluding preparation, except reconstitution of beverages. The MRE was developed for use in a combat zone. The MRE has 12 different menus which could serve a 12-day menu cycle of Space Station Safe Haven. After consideration and evaluation

of its quality characteristics, MRE foods could be possible candidates for Space Station Safe Haven Foods. The minimum limited shelf life for all emergency food types under Space Station stowage conditions is 3 years, but a recommendation of 7 years or more is possible. Therefore, more ground based studies under recommended optimum conditions are advisable. (1, 15)

RLW-30

A 2000 Kcal light weight ration (RLW-30) was tested as the sole source of food for 30 continuous days during a Special Forces field training exercise. Medical examinations did not reveal any serious medical problems, and there was no evidence of direct ill effects from the ration. Some members of the RLW-30 group noted trace urinary protein loss. Nutrient intake was adequate to meet military dietary allowances. The macro nutrients are intentionally reduced in the ration to meet size/weight constraints and reduce the water burden of the ration. Studies have not yet been completed on the limited life of the RLW-30. Therefore, a ground based study on longer shelf life beyond 7 years will be recommended. (1, 15)

Nutritional Sustainment Module

As currently specified, the Nutritional Sustainment Module (NSM) represents an entirely new concept for achieving compactness, convenience, and nutritional reliability in a combat ration. This has been developed to meet the challenge of the 21st century's stressful war environments. It is of the highest possible caloric density, approaching 7.1 Kcal/cc. A dismounted soldier will be able to easily carry a 3-5 day food supply meeting the 3600 Kcal daily requirements. Another objective of the NSM is optimum utility, consummable on the move without any preparation, and modular in design. For example, a 900 Kcal module would be able to combine with others to form rations of 1800, 2700, 3600, 4500 Kcal to meet specific combat scenario requirements.

A field test was conducted on the NSM 900 Kcal module. The positive characteristics of these rations are that it is compact, light, easy to carry, and easy to open for consumption. A module demonstrator has been developed with the following characteristics: 900 Kcal, 160 cc, 150 gm, 5.6 Kcal/cc, and 6.0 Kcal/gm. This demonstrator module exceeds the design criteria for caloric density, and represents an 86% reduction in the cube and a 70% reduction in weight over the current MRE.

The available shelf life of NSM as of today is 3 years. With the advancement of new technology in food science, a shelf life of NSM beyond 7 years is possible for subsisting in the battlefield of the future. (2)

Shuttle Foods

A few selected high density Shuttle foods are also future candidates for Space Station Safe Haven food service system. (15)

The Food Development Lab of the Johnson Space Center at Houston conducted the various studies regarding stowage volumes and weight for potential Safe Haven Foods for a 45-day supply. Table IV indicates the results of the study. (3, 4, 5)

**TABLE IV - STOWAGE VOLUMES AND WEIGHTS FOR POTENTIAL SAFE HAVEN FOODS
(45-DAY SUPPLY, CREW OF 8)**

FOOD SYSTEM	FOOD WEIGHT KG (LB)	MAKUP WATER WEIGHT KG (LB)	TOTAL WEIGHT KG (LB)	FOOD VOLUME CU.M. (CU.FT.)	WATER VOLUME (a) CU.M. (CU.FT.)	TOTAL VOLUME CU.M. (CU.FT.)	KCAL/MAN/ DAY
MRE (2 pkg/man/ day)	340 (750)	836 (1843)	1176 (2593)	.60 (21)	.84 (29.6)	1.43 (50.6)	2600
RLW-30 (1-1/4 pkg/ man/day)	204 (450)	998 (2200)	1202 (2650)	.34 (12)	1.0 (35.3)	1.34 (47.3)	2460
Standard Shuttle	571 (1260)	697 (1537)	1269 (2797)	1.70 (60)	.70 (24.7)	2.40 (84.7)	2750
Emergency Shuttle	317 (700)	937 (2066)	1255 (2766)	.71 (25)	.94 (33.2)	1.65 (58.2)	2670

(a) This volume does not include the containers for the water or any dispensing system.

Safe Haven Foods will be used only when there will be no Crew Emergency Rescue Vehicle (CERV) available and will allow 8 crewmembers to live for 45 days. A Nutritional Sustainment Module (NSM) can be used for CERV because of its preferable characteristics: compact, light, easy to open for consumption, and longer shelf life. In this paper, a 45-day mission was emphasized to establish the nutritional requirements for the Space Station Safe Haven food supply. An optional plan is under consideration for a more extended mission. Option I is the 45-day survival mission. Option II will be discussed as follows:

OPTION II

ASSUMPTIONS:

- Eight crew members
- Ninety-day duration - possible duration up to 180 to 235 days
- Two crew members will be assigned to perform extravehicular activities (EVA)
- All crew members will have IVA
- Induced reduction metabolic rate for crew members
- Available recycling water
- Stowage unknown
- High density foods will be used; Nutritional Sustainment Module (NSM) is a possible candidate
- Shelf life of food should be beyond 7 years

In Option II, ground-based research needs to be done to observe the cause and effect of an induced reduction in the metabolic rate. A mission of 180 to 235 days would be possible using different methods of reducing metabolic rates in human beings. This may involve the use of new developments in medical science. There are several methods which can be used for reduction in metabolic rate, i.e., decrease activity, sleep medication on a chronic basis, meditation, and others. The results of the ground-based studies will help to understand the percentage of reduction in the metabolic rate and will aid in planning and establishing nutritional needs for the future crew members of Space Station in similar situations.

In various research studies, the results indicate that starvation for 10 days can cause large body weight loss, high negative water balance resulting in body dehydration, negative nitrogen balance, a marked ketosis and abnormal EKG during the experimental phase; human performance remains remarkably good even under suboptimal nutrient intake for periods up to 24 days. (12, 14, 18) Therefore, if the crew members of Space Station plan to survive in an emergency situation for 180 to 235 days with minimum nutrients, an above mentioned alternative medical and nutritional plan needs to be under consideration. A temporary induced reduction in metabolic rate will minimize several problems in the contingency plan and will help to establish the nutritional needs for the crew members for longer durations.

SUMMARY

The concept of Space Station Safe Haven is to sustain 8 crew members under emergency conditions for 45 days. After careful study of different research findings in respect to starvation and calorie restricted diet, a minimum nutritional need close to the RDA is an important factor for sustaining an individual's life in a stressful environment. Fat, protein, and carbohydrates are three energy producing nutrients that play a vital role in the growth and maintenance process of human life. A lower intake of protein can minimize the water intake, but it shows significant effects of negative nitrogen balance and the lower performance level of the individual. Other macro and micro nutrients are also required for a nutritional interrelationship by allowing the first three nutrients to work in the body up to their optimum level. Therefore, 2000 Kcal Space Station Safe Haven Emergency/Survival food is recommended on the basis that 10% Kcal should come from protein, 60% from CHO, and 30% from fat, for 45 days.

FUTURE RECOMMENDATIONS

1. Adaptation training for different calorie restricted diets, e.g., 300 Kcal up to 900 Kcal.
2. Psychological testing for Space Station crew members concerning calorie restricted diet, as well as psychological impact from the absence of normal daily diet.
3. Physical training (i.e., exposure) regarding the stress and fatigue associated with significantly calorie restricted diet.
4. Study the crew members on the basis of mass and sex, and their impact on consumption of daily food in comparison with standard male and female size.

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